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ANNUAL REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1932-33

BY

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ANNUAL REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1932-33.

I have the honour to present the Administration Report of the Coffee Scientific Officer for the year ending 31st March 1933, dealing with the work in progress in connection with coffee problems.

As in previous years, the work has been centred at the Mysore Government Coffee Experiment Station, Balehonnur, under the direction of Dr. L. C. Coleman. Work in co-operation with the Officers at the Station has been continued in connection with breeding, spraying and miscellaneous problems.

The Assistant, Mr. V. K. Subramhanyam, has continued to work at the former Coffee Experiment Station at Sidapur, S. Coorg. His agreement was renewed in December for a further twelve months. At the end of February 1933, the Assistant was transferred to Balehonnur for the period of the Scientific Officer's home leave.

The report comprises, as usual, a short account of touring work, scientific investigations in progress, and general notes on coffee problems which have been raised during the year.

Touring.

Two visits were paid to S. Coorg during the year, one in June 1932, and the second in February 1933. Both of these visits were undertaken in connection with the supervision of the work of the Assistant. Opportunities were taken to meet and discuss questions with a number of Planters in Coorg on both occasions. On the second occasion arrangements were made for a small co-operative manuring trial in the coming year. Matters arising from these visits concern almost entirely the special problem for which the Assistant was primarily appointed and will be dealt with in the appropriate section of the report.

Investigations.

Leaf Disease.—Progress Report.—The work on Leaf Disease has followed the lines indicated by the work

carried out in 1931-32 and definite progress has been made in connection with study of the inheritance of resistance.

The results of the work in 1931-32 on spore germination, on resistance and susceptibility of different coffee strains to Leaf Disease, and on the existence of distinct strains of Hemileia indicated the absolute necessity of working with material grown in the laboratory under standardized conditions.

The first task during the year was the establishment of cultures which would be homogeneous and representative of the two strains discovered in the previous year.

This was carried out and several isolations were made from single disease pustules. These were maintained in the laboratory by periodic transference from one set of inoculated leaves to another fresh set.

Difficulties were mainly those of systematising the work to obtain steady supplies of spores of both strains and were inevitable in the early stages of the work. During the cold weather of December and January great difficulties were experienced in maintaining cultures and most of the isolations were lost. Fresh isolations were therefore necessary and up to the end of the year progress was seriously handicapped. New cultures were established during February and March and their strain determined. These will be utilized for testing work in the coming year.

The cultures isolated and tested in the early part of the year were utilized in testing the disease resistance of a number of coffee seedlings produced in the course of the Station's coffee breeding activities. The work has been slower than could be desired owing to the difficulties enumerated in the preceding paragraph, but enough has been done to indicate that the method of laboratory inoculation on detached leaves is likely to prove a very valuable weapon in tackling the problem of producing a disease resistant coffee.

The first results indicate that resistance is dominant to susceptibility and it is highly probable that the mode of inheritance follows comparatively simple Mendelian lines. It is too early to go into the details of the tests so far carried out as the tested seedlings are too few for sound deductions to be drawn.

From a practical point of view, it seems that it should be possible to establish coffee strains which will breed true for Leaf Disease resistance in a relatively short time. It remains to be seen whether other characters such as

normal flowers, good set and regular fruit production and even sample can be readily combined with this resistance. Work is proceeding as rapidly as possible on these lines.

At the same time, studies have been commenced on the phenomena of penetration of the germ tube of the fungus into the leaves of both resistant and susceptible coffee strains. By inoculating leaves with spores and then stripping off pieces of the leaf epidermis, a rapid method of studying the preliminary stages of infection has been developed. These stages have been followed from the first swelling of the germ tube over the stoma to the establishment of the first haustoria, or feeding organs of the fungus in the leaf cells.

The results indicate that resistance does not depend on any inability of the fungus germ tubes to enter the leaf through the stomata. In resistant leaves this entrance takes place quite normally and the entering tube may proceed to the formation of haustoria. So far, studies have not revealed the later reactions of the resistant host but work on this problem is planned. The conclusions are that resistance and susceptibility depend on constitutional differences in the protoplasm of the hosts and not to any great degree onw anatomical features. Similar work by Allen on wheat rust led to a similar conclusion.

Owing to the demands made on the Hemileia cultures by the testing of seedlings, little further work was possible on spore germination with spores grown under standardized conditions. The few expēriments carried out show a considerable increase in regularity and percentage of germination, and confirm the conclusions on the effect of moisture and light noted in last year's report. It may be said that for regular results in spore germination studies, spores must be produced under standardized conditions and collected in such a way as to obtain only fully ripe spores. A short period of preservation after collection appears to give the best germination results.

One experiment on the effect of bright and dim light on the development of pustules on detached leaves showed that dim light caused a reduction in the vigour of spore production. This is of interest in view of experience with respect to the incidence of Leaf Disease and the use of shade.

Further work along all these lines is contemplated in the future, with emphasis naturally on the inheritance of resistance.

Root Diseases.—Progress Report.—Little further work has been carried out on this problem but the results of the inoculation experiment started in November 1931 and reported in last year's report are of interest. This experiment was carried out with the fungus of Brown Root Disease, usually called Fomes lamaœnsis. Pure cultures established on wood blocks were buried in contact with the tap root or lateral roots of a number of coffee plants planted in tubs. These plants were under somewhat unfavourable conditions and suffered very severely from Leaf Disease and both inoculated plants and controls were completely defoliated. It was noted that some plants were suckering after this defoliation, while others did not appear to be doing so. The plants were dug out in January 1933, about fourteen months after the experiment was started. Out of the four plants inoculated, two showed the typical signs of infection by Brown Root Disease, while two were free; the two control plants were also free. The two plants which showed successful infection were those in which the wood blocks had been placed in direct contact with the tap root, while the unaffected plants had the blocks placed only near a lateral. It was not possible to see whether the laterals in contact with the blocks had been destroyed by the disease. If they had however, the typical symptoms were not found near the tap root, and the root system appeared otherwise healthy.

In the plants showing symptoms, the disease had not succeeded in ringing completely the tap root, and the upper part of the plant was still green under the bark.

It is true, conditions were somewhat unfavourable for the plants and the experiment requires repetition under more satisfactory conditions, but the results show that the rate of development of the disease is slow and they emphasize the necessity of including a ring of apparently healthy trees within an isolation trench when this method of limiting the disease is employed.

It is highly desirable that experiments along these lines should be continued with special reference to the effect of soil moisture and æration on the rate of development of the disease. It is proposed to follow these lines in the future.

Studies on Spray Mixtures.—The leaf count method of studying the relative value of different adhesives and mixtures was followed in these studies as in previous years. The results have been dealt with in a bulletin on

spraying and it is unnecessary to consider them in full detail in this report.

The results do not alter the conclusions arrived at from previous work. As far as the leaf counts are concerned, there are no marked differences in the effectiveness of the principal spray mixtures tried. A study of the percentage infection of the leaves suggest that the sprays may be divided into two groups, one, including casein, resin soda and linseed Bordeaux, being slightly less infected than the other which includes alum Bordeaux and resin soda Burgundy. Fish oil resin soap Burgundy occupies a doubtful intermediate position.

The sprays applied without any adhesive were as effective during 1932 as those with adhesives, the Bordeaux giving the lower amount of leaf, with, however, a much lower percentage of disease. These results may be regarded as due to the less severity of the disease in the experimental plots in 1932 than in 1931, when the use of adhesive had a significant effect in improving the protection afforded by Bordeaux.

The results for the sprays now being studied are given in Tables 1 and 2.

TABLE 1.

Leaf Count data for different Types of Sprays.

	1930	1931	1932
Linseed oil Bordeaux 10 ozs. ...	6·35±·21	6·28±·23	5·93±·21
Alum Bordeaux ...	5·38±·24	6·00±·28	6·63±·25
Casein Bordeaux ...	5·90±·18	6·19±·24	5·84±·17
Resin soda Bordeaux ...	5·50±·16	5·94±·20	5·94±·21
Fish oil resin soap Burgundy ...	5·57±·23	5·66±·26	5·99±·24
Resin soda Burgundy ...	4·87±·18	5·97±·21	6·06±·22
No adhesive Bordeaux ...	...	5·40±·19	5·60±·17
No adhesive Burgundy ...	...	...	6·32±·21
Controls no spray ...	2·40±·13	3·13±·17	4·27±·23

The spray mixtures which have been tested for three years are arranged in descending order as indicated by the mean value of the three observations carried out for each treatment.

TABLE 2.

Percentage Infection Data for different Types of Sprays.

	1930	1931	1932
	Per cent	Per cent	Per cent
Linseed oil Bordeaux 10 ozs. ...	29·3	26·8	14·1
Alum Bordeaux ...	40·5	51·3	24·7
Casein Bordeaux ...	26·2	26·1	10·4
Resin soda Bordeaux ...	32·1	30·3	14·1
Fish oil resin soap Burgundy ...	30·7	32·6	22·3
Resin soda Burgundy ...	34·9	42·7	21·7
No adhesive Bordeaux ...	...	42·2	9·5
No adhesive Burgundy ...	...	...	19·6
Control no Spray ...	49·4	72·5	75·5

Time and Strength of Spray Studies.—These results obtained by methods similar to those employed in the study of different types of spray have also been dealt with in the bulletin on spraying referred to above. Observations were carried out in September 1932 and February 1933 as in the previous years, and the results confirm the conclusions reached in previous reports. The data for 1932-33 are summarized in Table 3. For detailed discussion of these results, reference should be made to the bulletin on spraying.

TABLE 3.

Leaf Count Data and Percentage Infection. Time and Strength of Spray.

	September 1932		February 1933	
	Leaf Count	Per cent	Leaf Count	Per cent
Control Plot 1 ...	3·25	69·6	2·74	21·5
1 per cent May and Sept. Spray.	6·49	51·0	3·21	22·8
Control 2 ...	4·22	73·4	2·43	20·7
1 per cent May Spray only	6·61	19·2	2·73	40·0
Control 3 ...	4·66	67·1	2·52	18·1
0·5 per cent May and Sept. Spray.	6·61	45·7	3·80	32·6
Control 4 ...	5·31	58·7	2·50	26·0
0·5 per cent May Spray only.	6·96	25·1	2·25	38·1
Control 5 ...	5·48	62·5	2·36	24·4
1 per cent Sept. Spray only	4·18	79·8	3·22	24.8
Control 6 ...	4·63	71·3	2·13	31·0
0·5 per cent Sept. only ...	4·03	73·5	2·87	33·0
Control 7 ...	3·78	71·8	2·66	29·9

It must be noted that the variation in the control plots throughout the series is due in part to the continued effect of differential treatments in the first year of the experiment (1930), though doubtless variation in soil and shade conditions over the large area covered by the experiment also plays a part.

It may be considered strange that the amount of leaf carried in February by the sprayed plots is but little greater than that carried by the control plots. This is due to the fact that the observations make no distinction between old mature leaf and newly developed leaf. In the case of the controls a large proportion of the leaf counted in February is new leaf formed since September, while in the case of the sprayed plots this proportion is considerably smaller. The larger leaf "flush" in the intervening period between the two counts in the case of the unsprayed plots is a matter of importance as the utilization of food materials during this period for leaf production means a reduction in the supply of food for blossom bud formation. Hence, the data for leaf amount in February do not reveal completely the differences due to spraying.

Observations on shoot development in the period, September to February, also reveal a greater production of shoots in the unsprayed areas involving further utilization of materials which in the sprayed areas go to form flower bud.

Flower and Fruit Studies.

Crop Losses during Development.—Observations of the same type as those reported last year were carried out in the 0·5 per cent twice sprayed plot in the Time and Strength of spray experiment. They included regular observations of loss of young fruit and the development of leaf and shoot on 100 cropping branches.

In last year's report, the loss was divided into four groups and of these, the fourth group covering the period from the 11th week of development to the harvest was much the smallest. This year's results confirm those of 1931, but the separation of the first three groups of losses is not as easy as in the previous year as there was considerable overlapping, and from the data available it was not possible to sort them out with any clarity.

The final percentage of fruit picked was 41·4 per cent of the original bud, a figure only slightly different from last year. This was particularly striking in view of the considerable difference in the amount of bud produced, and in the climatic conditions during the early stages of fruit development. Once again, it is shown that losses of developing fruit occur almost entirely between the blossom showers and the monsoon, provided that losses due to Black Rot and Die Back are eliminated by spraying. An analysis of the data for losses during development is given in Table 4, together with last year's figures.

Table 4.

Percentage Loss of Crop during Development.

	1931		1932	
		Per cent		Per cent
Original Flower Bud ...	9031	...	5379	...
Loss 1. First four weeks ...	1850	20·5	1411	26·2
Loss 2. Unswollen fruit at 5th week.	989	11·6	599	11·1
Loss 3. 5th to 11th weeks ...	2414	26·7	902	16·8
Loss 4. 11th week to harvest	381	4·2	241	4·5
Fruit picked ...	3397	37·6	2226	41·4

The chief difference from last year is a slightly higher loss in the first four weeks, and a somewhat lower loss between the 5th and 11th week. It is impossible to attempt any correlation with climate on such meagre data, but the rainfall conditions from March to June for the two years are given in Table 5.

TABLE 5.

Amount of Rainfall in Inches.

	March		April		May		June	
1931 ...	1·59	1	7·02	11	3·11	9	10·44	23
1932 ...	·03	1	4·29	13	9·01	17	8·37	27

The blossom in 1932 was ten days later than in 1931; in the latter, the blossom shower of 1·50″ fell on March 24th and the flowers opened on April 1st. Heavy rain fell on April 4th, 5th and 6th and there were showers at fairly frequent intervals until the beginning of May after which there were three weeks without rain. In 1932, blossom showers of ·76″, ·46″ and ·04″ fell on April 4th, 5th and 6th and the flowers opened on the 12th and 13th. There were small showers of 9 and 8 cents on these two days, followed by a dry week, after which rain fell at frequent intervals. The latter part of May was characterized by well marked S. W. Monsoon condition, June was a month of light rainfall, but there was no drought.

It is impossible to say what amount of variation there is in percentage set in different districts, but that there is a considerable variation seems highly probable. However, for a fruit crop, a set of 40 per cent or thereabouts must be considered satisfactory.

Working on the basis that the greatest losses occur in the period prior to the commencement of the monsoon, a series of observations were made on plots receiving different manures to see if it was possible to establish any differences in the setting due to different treatments. The plots selected for study were those receiving nitrogen alone as 3½ cwt. of groundnut cake, phosphoric acid alone as 1 cwt. of concentrated superphosphate and potash alone as 1 cwt. of a mixture of muriate and sulphate. A further

series of plots which had received no manure for seven years were also studied.

There were three plots studied for each treatment, and at each observation, 25 typical shoots similar in every respect to those utilized in the more detailed observations noted above were counted in each plot. Observations were made just before blossom, at the seventh week after blossom and just prior to the harvest. No attempt was made to keep the same branches under observation throughout the season as the extra work entailed could not be spared at the times of observation. The evidence from the more detailed counts shows that any 25 branches are likely to give sufficiently similar figures for the purposes of these observations.

The amount of bud on 25 branches varied widely in different plots receiving the same treatments. On taking the total number of buds counted for each treatment, *i.e.*, the sum of the observations in each set of three plots, quite a remarkable agreement is shown for two of the treatments and the check plots. The results are tabulated in Table 6.

TABLE 6.

Counts of Buds and Fruits for different Manurial Treatment.

	Nitrogen	Phosphoric acid	Potash	Control
Buds at Blossom Time ...	4497	3995	3961	3983
Young fruit, 7 weeks later...	2593	2634	2370	2390
Fruit at maturity ...	1911	1703	1606	1841

The main features of interest are the considerably higher amount of bud in the nitrogen series when compared with the other three, the notably smaller failure in the phosphoric acid series in the first seven weeks and the larger failure later on in the same series.

Calculating the percentage set for each plot and estimating the standard error for each treatment, the following figures are obtained in Table 7.

TABLE 7.

	Nitrogen	Phos. acid	Potash	Control
	per cent	per cent	per cent	per cent
Percentage set out in first 7 weeks...	58·3±3·7	66·2±3·9	60·2±4·1	61·4±5·7
Final percentage set	43·0±2·6	42·3±2·6	41·2±3·4	48·0±5·9

The results do not reveal any definite difference in setting due to individual manuring treatments and further results would be required before any definite conclusions could be drawn. Two points in particular require following up, the higher bud production in the nitrogen manured plots and the slightly lower loss in the early stages in the phosphoric acid manured plots.

Examination of the Crop picked.—The crop picked in the main set of observations was examined and classified as last year. The results are tabulated for comparison in Table 8.

TABLE 8.

Analysis of Fruit Picked in Crop Development - Observations.

	1931	1932
Total Fruit	3397	2226
Per cent Peaberry	13·3 per cent	21·5 per cent
„ Three Bean Cherries ...	1·0 „	1·0 „
„ Total Beans ...	6376	4001
„ Empty Beans ...	2·0 per cent	2·3 per cent
„ Black Beans ...	11·9 „	0·3 „

Two very striking features emerge : the higher amount of peaberry and the much lower amount of Black Bean in 1932. No very satisfactory explanation can be provided for either of these differences on the data available at present. The question of Black Bean will be considered below.

Black Bean.—The defect known as Black Bean was studied during 1931-32, when it was concluded that it was probably due to physiological disturbances connected with supply of nutritive material under certain climatic conditions as yet undetermined. Attempts to study the disease in 1932 were largely handicapped by the scarcity of material indicating the absence of the predisposing conditions. However, a little information was obtained by the examination of samples of young fruit at monthly intervals from June to August. The first indication of any Black Bean was found in the middle of August when one or two fruits in a sample of 300 showed the beginnings of blackening of the bean tissue. This was associated with a fundamental change in the nature of the "meat" of the bean.

It was found that at this stage, the bean showed the transition from the green, rather watery stage to the ivory white stage which eventually forms the hard bean in the ripe fruit. This transition appeared as a form of replacement rather than one of transformation of the existing tissue, since the white tissue, which at this stage is soft, was quite separate from the green tissue and could be removed as a whole with a needle. Sections of the green tissue showed thin-walled cells with sparse contents and the cells at the edge in contact with the soft white tissue appeared to be collapsed. The green tissue cells contained no apparent storage material but the white tissue was packed with globules giving fat reactions. At the limiting layer between the two tissues, there seemed to be a marked concentration of protein materials. In the one or two beans showing the beginnings of what looked like Black Bean, the blackening was at this limiting layer.

It seems that the development of Black Bean is bound up with a fundamental change in the tissues of the bean which occurs about August.

On the data so far available, little more can be said but the evidence obtained during this year supports strongly the conclusions reached last year. This subject will be studied further in future years, especially with reference to the change occurring in the bean during development, and their relation to climatic and nutritional conditions. Results from work of this description are bound to be slow.

Brown Spot.—In December, attention was called to another bean disease characterized by more or less limited

brown and sunken spots on the bean which were visible through the parchment when it was wet. There was no sign of disease or penetration on the parchment and, in some cases where this bean spot has been found in cherries under examination, no visible indications of damage on the exterior of the fruit. Fungus hyphæ were found in the attacked areas and several organisms were isolated. Inoculations were started by pricking spore suspensions of the suspected organisms through the parchment of surface sterilized beans. In the case of one bean in a series inoculated with a species of Fusarium, a black spot developed at the point of inoculation, and this fungus has been kept in culture for further work next season. The spot developed artificially was not quite like those found in the diseased beans sent in so that it cannot be said that the inoculation gave any proof of the pathogenic nature of the fungus used. If further work proves this, the problem of the mode of infection will require investigation.

Mealy Bug, Cockchafer and Nematodes.—The work carried out in Coorg on the loss of plants attributed to Mealy Bug and Cockchafer is the subject of a separate report. This work has been carried out by the Assistant, appointed in December 1931, and the results of his work have amply justified the appointment.

It has been found that the greater part of the trouble in South Coorg is to be attributed to the activities of a species of Nematode, a minute worm which bores into the root tissues and destroys them. This worm, known as *Anguillulina pratensis* (*Tylenchus coffeae*), has been known as a serious pest of coffee in the Dutch East Indies for many years, but this is the first record of it from India. Further details on the work so far carried out will be found in the separate report referred to above.

General Remarks.—The year on the whole in Mysore showed few exceptional features, though blossom showers were not entirely favourable in some areas and were bad in Coorg. The rains in May were very heavy, monsoon-like in character, but they did not seem to be the cause of any considerable damage. It was a bad year for Black Rot and this disease was noticeable up to a very late date in the year, the N. E. Monsoon being heavy and continuous.

The year was noticeably a bad borer year, doubtless as a consequence of the dry October in 1931. It is

likely that 1933 will show a much lesser severity of this pest.

The Black Bean trouble which was so serious in 1931, was almost completely absent in 1932, and in Mysore, crops turned out well.

Coffee looked well in the early months of 1933 but blossom showers fell very early and were in a number of cases rather small. Blossoming was irregular and some failure was evident.

Other Diseases.—Apart from the bean spot and the eelworm diseases mentioned elsewhere no serious diseases not previously reported have been noticed. Two minor diseases may be mentioned, though neither appear to be of any practical importance. Specimens were received of leaves and fruit affected with large brown discoloured blotches from which a species of *Colletotrichum* was isolated, culturally similar to the species isolated from Die Back. This disease is not new, having been reported by Butler in "Fungi and Disease in Plants" and is of some practical importance in East Africa. A new fungus was found on leaves showing symptoms similar in some respects to Black Rot, in an area where Black Rot was present. Closer examination revealed a strong resemblance to Thread Blight, a disease reported from Java. Specimens were sent to Mr. M. J. Narasimhan, Mycologist, Mysore Agricultural Department, who has been studying this type of disease.

Pests.—Stem Borer (*Xylotrechus quadripes*) was much in evidence during the year. The only observation of interest made during the year was the considerable part that spraying with Bordeaux plays in reducing borer losses. The effect is of course, indirect, through the increased leaf cover provided during September and October. The results in parallel plots at the Experiment Station were most marked and were discussed in the spraying bulletin.

Bugs.—In addition to the usual scale insects, mention must be made of the identification of one Mealy Bug found during the work in South Coorg, which, while it appears to be of no great importance in South India, is identical with the very serious Mealy Bug found in East Africa. This is *Pseudococcus lilacinus Ckll* found on shoots of both *Erythrina* and coffee. There have been three Mealy Bug species found associated with coffee up-to-date.

Pseudococcus citri; *Riss.*—On roots.

Pseudococcus virgatus Ckll.—On leaves and shoots.

Pseudococcus lilacinus Ckll.—On leaves and shoots.

The importance of the first is still somewhat uncertain though probably under some conditions it is a cause of loss of vigour of young plants, opening the way to more serious root enemies. The second has only once, in Coorg in 1929, given cause for alarm on a small area, while the third, so far, has no practical importance. The two latter must be regarded as potentially serious pests and any cases of sudden outbreaks of Mealy Bug on leaves or shoots should be promptly dealt with by a contact spray such as Fish Oil Resin Soap, in order to limit any tendency to spread.

Eelworms.—The eelworm attacking coffee has been dealt with elsewhere. In addition to this species, another species causing root galls has been found in South Coorg on *Erythrina*. This root gall eelworm has previously been reported from Ceylon on the same host and from both Ceylon and South India on tea.

Correspondence and Publications.—Correspondence has shown further increase, over 300 enquiries having been dealt with during the year. As in previous years these have been concerned mainly with spraying and manuring.

A report on " The relation of Nematode worms to the Cockchafer and Mealy Bug Problem in South Coorg " was prepared in association with the Assistant Scientific Officer. A bulletin on the spraying of coffee was prepared in co-operation with Mr. M. J. Narasimhan, Mycologist and Mr. K. H. Sreenivasan, Assistant Director of Agriculture, Mysore Department of Agriculture.

Three articles, " Recent Work on Coffee Leaf Disease ", " Black Bean or ' Jeloo ' in Coffee " and " Spraying in relation to Coffee Crop Production " were published in the " Planters Chronicle ". An article on the control of coffee Leaf Disease was contributed to the Planting Supplement of the " Madras Mail."

Acknowledgments.—I have to express my very great appreciation for the continued cordial advice and assistance which has been given me at all times by Dr. Coleman and his staff both at the Coffee Experiment Station and at Bangalore.

My thanks are also due to the many planters who have, from time to time assisted me in various phases of the work here recorded.

The work of the Assistant, Mr. V. K. Subramhanyam has been excellent under somewhat difficult conditions. Substantial progress in studying the problem in South Coorg has been made through his efforts and though as yet this progress has not reached the stage of practical control, there could be no hope of any control without the more accurate diagnosis of the problem now available.

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